

Table 1-HCC Sediment and Geomorphology Analysis

Issue	Within HCC	Below HCC	Comment
1. Size of Sediment	<p>Shallow surface samples collected from the lower-reservoir segment (RM 310 to RM 285) also are dominated by a silt-clay grain size that averages 99 percent by weight (Parkinson et al. 2002). Of the remaining 1 percent, the average percent of very fine sand is 0.5 percent, fine sand is 0.3 percent, and medium sand is only 0.1 percent. <u>It is unclear what proportion of the sand is contributed by upstream sources versus local tributary sources.</u> (Page 4-21 Appendix E.1-2)</p> <p>Coarser sand and gravels (3 percent) are present primarily in the headwaters of Brownlee Reservoir. <u>Local tributaries also produce sediment that is retained in the HCC and this material contains a relatively higher proportion of sands and gravels. The coarser sediments that have been retained upstream as a result of the HCC are likely only a minor portion of the total downstream coarse sediment supply</u> (Page 4-1 Appendix E.1-2)</p>	<p>Of the 15.1 million tons, approximately 42 percent is in the spawning gravel size (50 mm-150 mm), and 15 percent is in the sand size range (0.062 mm-2.0 mm; Parkinson et al. 2002). As discussed in Section 5.3.2., these sediment sizes are the most useful in maintaining channel features such as spawning sites and sand bars. (Page 5-16 Appendix E.1-2)</p>	<p>Sampling in Brownlee Reservoir was done in the delta where mostly fine-grained upstream deposits accumulate and along the thalweg, where one would only expect successively smaller particles to settle as distance increased from the delta. It does not appear that any attempt was made to sample tributary delta deposits to determine quantitatively either their volume or size distribution since HCC was built and inundated. The acknowledgement that “Tributaries to Oxbow and Hells Canyon reservoirs (mainly the Wildhorse River and Pine Creek) also produce sediments. Materials from these tributaries contain a relatively higher proportion of sands and gravels than those trapped in Brownlee Reservoir. . .” (E.1-14, Draft Application) is a weak substitute for the quantitative estimation done downstream of HCC and is seemingly justified by lack of useable bathymetric data.</p>
2. Importance of Sediment to local rapids and stream morphology	<p>Local tributaries—which include the relatively large Burnt and Powder rivers and the relatively small Wild Horse River and Pine Creek drainages—are steep and periodically erode and produce sediment. <u>Coarse materials from local tributaries were typically deposited in this reach, as evidenced by islands and rapids that were present prior to the completion of the HCC</u> (Blair et al. 2001).</p>	<p>Alternatively, <u>morphologic rapids may occur where episodic debris flows and tributary floods deposit boulders in the mainstem channel.</u> The channel gradient of the mainstem river is typically insufficient to mobilize these boulders, so that over time extensive boulder rapids can develop adjacent to debris fans. (Page 5-10 Appendix E.1-2)</p>	<p>The fact that rapids and pools were present as a result of tributary deposition prior to the HCC pools should be some indication of the contributory importance of sediment derived from local sources within the HCC. That is, similar river morphologies influenced by local sediment contributions existed from Farewell Bend through Hells Canyon.</p>

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3. Sediment Yield Methodology	<p>The watersheds contributing directly to the HCC generally have different topographies, geology, lithology, and hydrology than the watersheds downstream of HCC. These differences result in lower sediment yields than those found for the watersheds downstream of the HCC. For example, slope is directly related to sediment discharge. <u>Because watersheds feeding into the HCC tend to have lower slopes, they would contribute less sediment than those below the HCC.</u> (E.3-12 Draft Application)</p>	<p>The tributaries for which the sediment supply was calculated (between the HCC and the Salmon River [not including the Imnaha River drainage]) account for approximately 55% of the total watershed area. <u>The average sediment yield from these tributaries was applied to the remaining 45% of that area, for an estimated total sediment supply of 16.6 million tons per year</u> (Technical Report E.1-1).(E.3-13 Draft Application)</p>	<p>The conclusions drawn differ in that one is completely qualitative, while the other is semi-quantitative. This demonstrates the lack of rigor in applying methods to make reasonably uniform sediment estimations in all reaches. For example, the estimated yield from Wildhorse River on the within HCC reach is 165 tons/sq. mi./year, yet IPC applies an “. . . average sediment yield of 28,100 tons/square mile/year . . . [below HCC]. . . given the characteristics of the tributaries in Hells Canyon including steep slopes, relatively small drainage areas, and limited ground cover resulting from arid conditions, high sediment yields . . .” (Page 5-16, Technical Report E 1-2). It does not appear that any contributory effects from small local tributaries or hillslopes within HCC are included in the analysis, resulting in an absolutely incredible estimate for downstream sediment production that is 170 times the within HCC estimate, even though the characterization quoted above for Hells Canyon (steep slopes, relatively small drainage areas, etc) would seem to apply to the entire reach from Farewell Bend downstream.</p> <p>Certainly the application and technical reports do not provide enough comparable analysis of the within HCC reach to make the general conclusion, “The watersheds contributing directly to the HCC generally have different topographies, geology, lithology, and hydrology than the watersheds downstream of HCC. These differences result in lower sediment yields than those found for the watersheds downstream of the HCC.” While applying the sediment yield estimates used downstream from HCC to the within HCC reach may not be appropriate if there are truly demonstrable differences in slope, lithology, etc. , it would nonetheless be more objective, comparable, and reasonable than the approach used here.</p>

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Hillslope Sediment Production	I found no mention of hillslope sediment contribution for the reach within HCC.	...steep hillslopes along the mainstem (62% have a slope greater than 40 degrees) have provided a significant supply of sediment over the last 1,000 years and probably over a much longer geologic time. (E.1-14 Draft Application)	Figure 4.4 (Technical Report E 1-2) would suggest that steep hillslopes within the HCC should be comparably important as potential sediment sources, given the visual comparison of area in over 40% slopes in both the within and below HCC reaches. Figure 5-15 and Table 5.6 in Technical Report E. 1-2 provide a breakdown of slope categories for the downstream HCC reach, but no comparable analysis is available for the within HCC reach. Again, it appears that the within HCC reach is not being examined with comparable methods or rigor, with either the intentional or inadvertent result of underestimating sand and coarse sediment production from local sources within the HCC, which, in turn, is used by the applicant to imply that sediment entrapment effects of HCC are minimal.

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Importance of Extreme Events	<p>...transport calculations show that within the 1% exceedance flow, Pine Creek does not mobilize its bed, but Wildhorse River does. Therefore, <u>Pine Creek does not contribute any sand-sized and larger sediments</u>, while Wildhorse River does. Although <u>Pine Creek did mobilize its bed during the 1997 flood event, the flows during this event far exceeded the 1% exceedance flow</u> (calculated as the daily average by month, not as annual peak) used in our analysis. . (E.3-12 Draft Application)</p>	<p>In general, short-term sediment yield estimates based on conventional <u>sediment yield measurements tend to greatly underestimate the long-term supply of sediment</u>. For example, Kirchner et al. (2001) recently conducted a sediment yield study in mountainous central Idaho that suggests that conventional sediment yield measurements made over decades greatly underestimate (by an average of 17 times too low) the long-term (over millions of years) average rates of sediment delivery. In Hells Canyon, long-term (100s to 1000s of years) sediment yields in the tributaries are also likely larger than the short-term yield estimates. However, several factors appear to somewhat limit the volume of sediments that are mobilized from the tributaries to the mainstem channel. Annual peak flows mobilize sediments in the upper portions of the tributaries, but most of this sediment is prevented from reaching the mainstem until more extreme flows are episodically available. <u>Extraordinary streamflow events such as rain-on-snow conditions appear to create sufficient stream flow to mobilize a considerable amount of accumulated sediments from storage into and through the narrow creek channels leading to the Snake River. An example of this occurred in January 1997</u>, when debris flows mobilized substantial volumes of tributary sediment throughout the Hells Canyon reach. (Page 5-17 Appendix E.1-2)</p>	<p>The within HCC analysis acknowledges the 1997 flood event mobilized the bed of Pine Creek, but dismisses this as a greater than 100-year flood event and doesn't count any contribution of sand and larger sediments from Pine Creek. The estimate from Wildhorse River is 165 tons/sq. mi./year. There is no estimate from other local tributaries or for hillslopes and no contributory effect from extreme events.</p> <p>In contrast, the downstream HCC suggests the sediment yield estimates are underestimated because of extreme events. It even uses the same 1997 event discounted in Pine Creek to emphasize the importance of such events, and includes documentation of debris flows, landslides, avalanches, etc. and other episodic events.</p> <p>There does not appear to be any credible justification in the application or technical reports why such extreme events would not also be important historical and future sediment contributors to the within HCC reach.</p>
Description of Tributaries	<p>Other than a discussion of the Burnt River, Wildhorse River and Pine Creek, the local tributaries are not discussed, nor, does it appear, are they included in the analysis of sediment contribution for the within HCC section.</p>	<p>...given the characteristics of the tributaries in Hells Canyon including steep slopes, relatively small drainage areas, and limited ground cover resulting from arid conditions, high sediment yields are expected. . (Page 5-16 Appendix E.1-2)</p>	<p>Technical Appendix E.1-2 provides a base map of all the tributary streams included in the sediment analysis (Figure 5.1). Nothing comparable is provided for the within HCC section. This is yet another example of the unbalanced analysis apparently intended to understate the sediment retention effects of HCC from local tributaries.</p>
Land Use Description	<p>Upstream from the HCNRA in the canyon, the river corridor supports a small amount of cattle grazing. This land is considered poor quality for grazing because of the steep terrain and the overgrazed condition of the flat areas. . (Page 2-18 Appendix E.1-2)</p>	<p>After 1975, there was a major shift in land uses toward recreation; this shift resulted in a more stable vegetative cover with lower local erosion rates and sediment supplies. . (Page 2-18 Appendix E.1-2)</p>	<p>Although there is some overlap with the HCNRA into the within HCC reach, the land use descriptions provided would suggest that expectations for sediment yield as a result of land use influences would be greater for the within HCC reach than downstream of HCC.</p>

